Assembly of 10mm θ-φ reference design fiber positioner

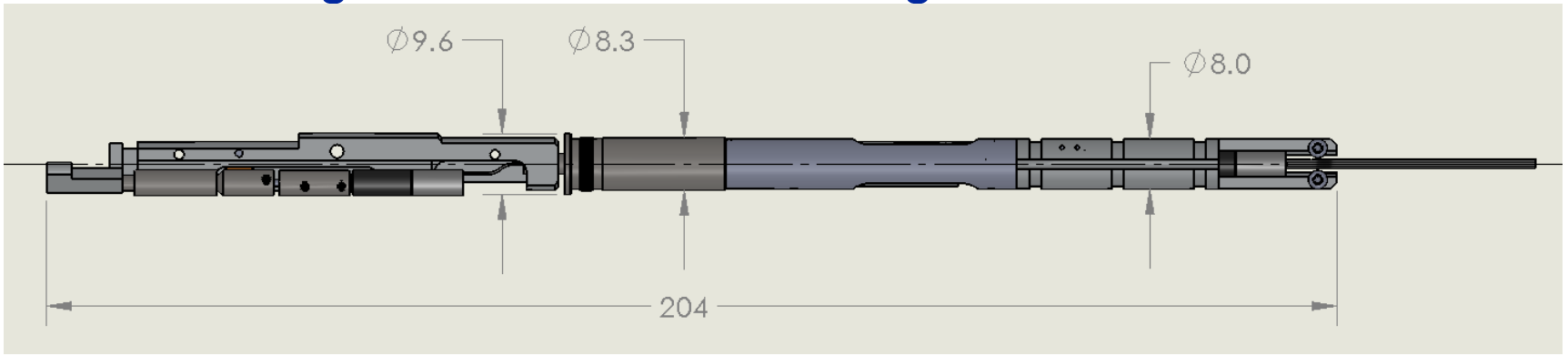
April 2014

Extracted from RFI of September 2013

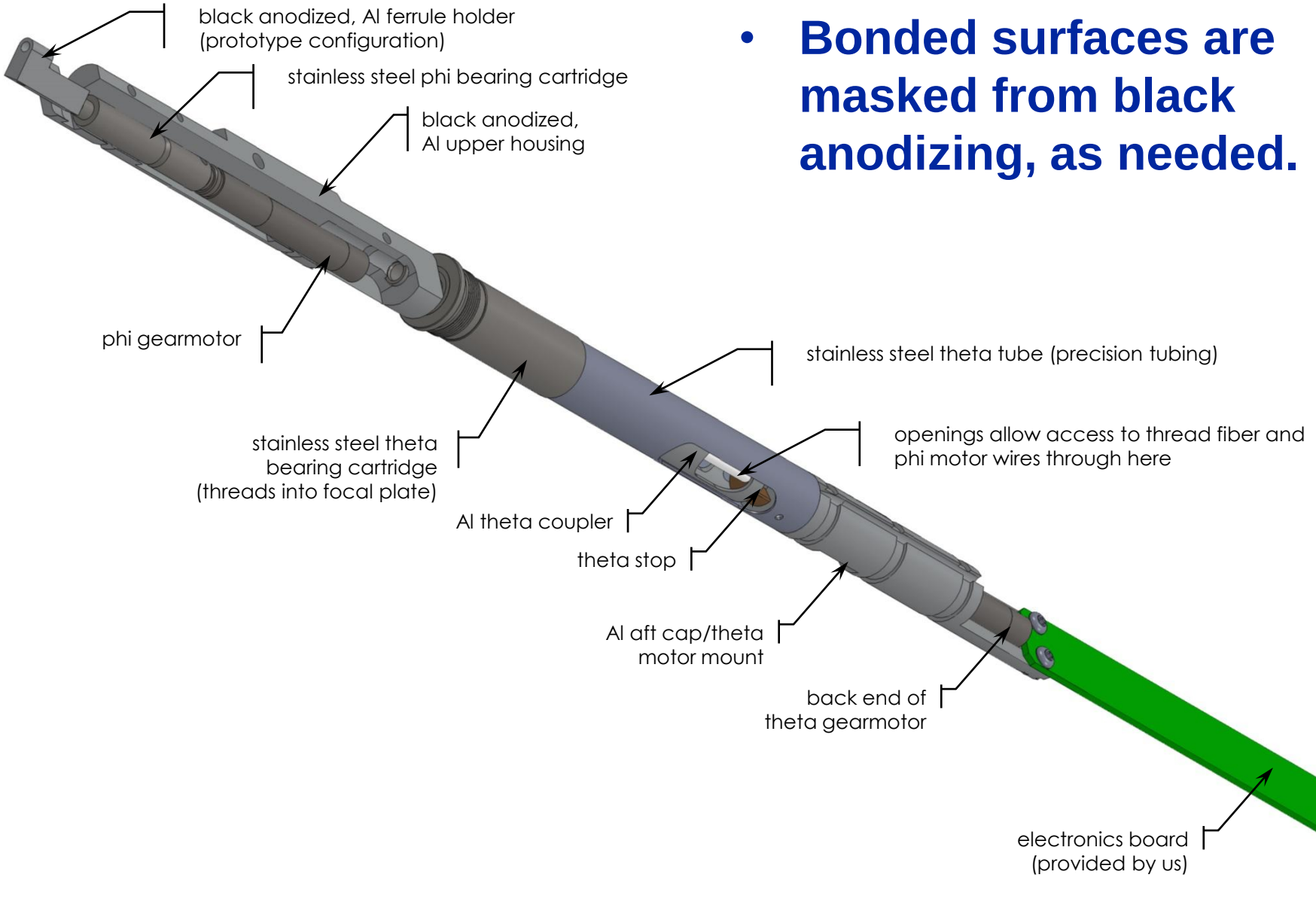
(some items are slightly outdated)

10.4mm reference design

- Machined parts
- Exposed surfaces on upper (phi) stage are black wherever possible for stray light management.
- Critical assemblies bonded on a precision fixture
  - Generous allowance for bond thickness variation
  - Accuracy comes from accuracy of fixture
  - Tight tolerances are on fixturing, bearing cartridges, bores where shafts are clamped with set screws, and theta idler bore.
- Precision co-aligned bearing cartridges
- Theta-stop employs idler to allow 365° of rotation
- 185° of phi rotation
- fiber routing drives much of the design

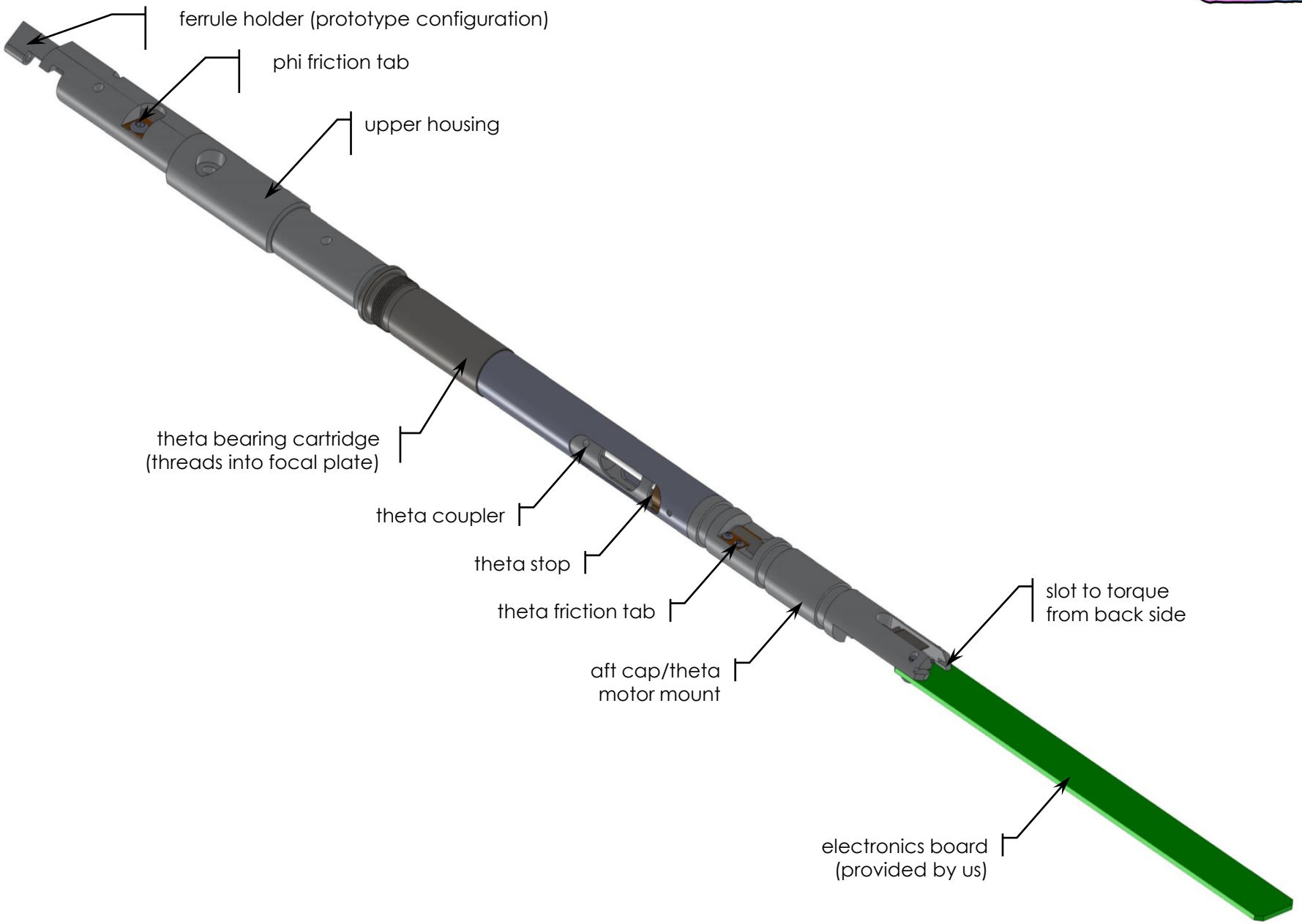


Isometric view 1



- **Bonded surfaces are masked from black anodizing, as needed.**

Isometric view 2



Positioner Parts List

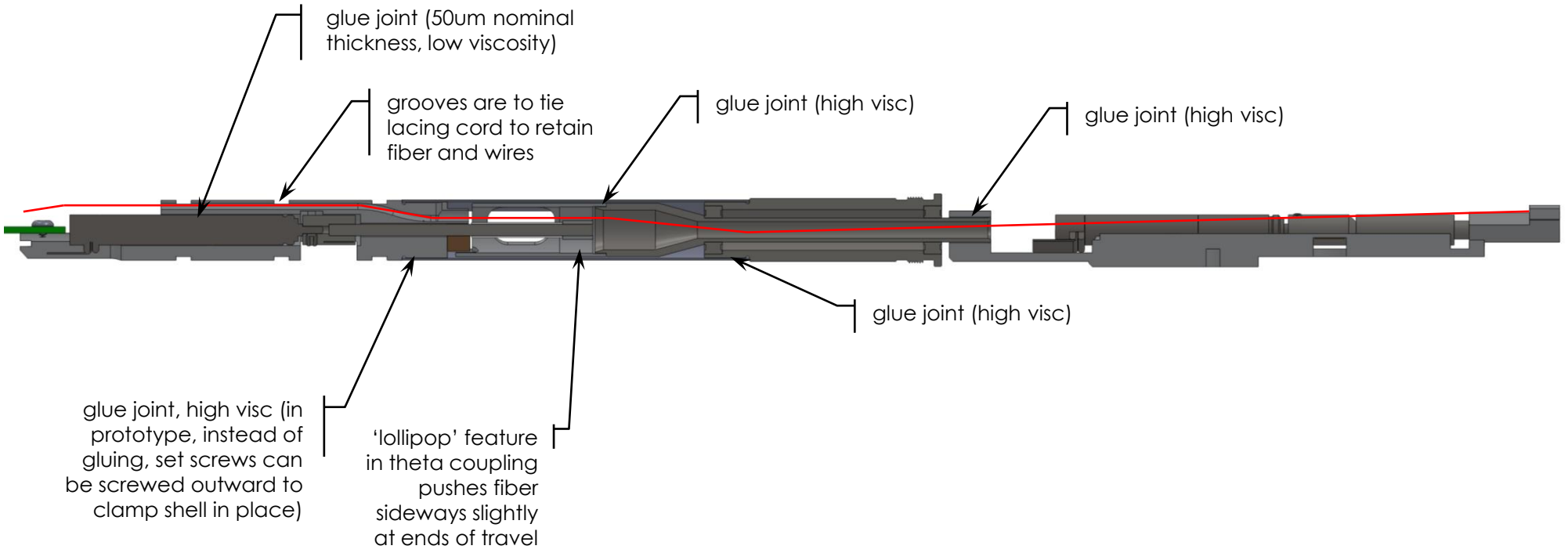
PARTS					
	Category	Qty / POS	Description	Part #	Rev
	Assembly		Positioner 10mm Theta-Phi	DESI-doc-524	
	Bearing	1	Phi Bearing Cartridge 10mm Theta-Phi	DESI-doc-565	A
	Bearing	1	Theta Bearing Cartridge 10mm Theta-Phi	DESI-doc-566	C
	Consumable	0.100	Epotek 301-2 (theta motor to aft cap)		-
	Consumable	0.3	DP420 Adhesive, black, 37mL cartridge	7467A51	-
	Consumable	0.3	DP460 Adhesive, off-white, 37mL cartridge	7467A26	-
	Consumable	0.1	Loctite 493 (phi shaft to phi coupler, th shaft to th shaft xtndr)	74985A69	-
	Hardware	10	socket set screw, cup point, 0-80 x 1/16" SS	92311A050	-
	Hardware	3	Button head torx machine screw, 0-80 x 1/8", SS	90910A665	-
	Hardware	1	Dowel Pin, 1mm x 20mm	91585A005	-
	Hardware	1	Dowel Pin, 1mm x 10mm	91585A004	-
	Hardware	2	Button head torx machine screw, 000-120 x 1/8", SS	90910A600	-
	Machined	1	Aft Cap 10mm Theta-Phi	DESI-doc-491	A
	Machined	1	Theta Housing 10mm Theta-Phi	DESI-doc-492	A
	Machined	1	Idler 10mm Theta-Phi	DESI-doc-493	A
	Machined	2	Namiki Extender 10mm Theta-Phi	DESI-doc-494	A
	Machined	1	Theta Coupling 10mm Theta-Phi	DESI-doc-495	A
	Machined	1	Upper Housing 10mm Theta-Phi	DESI-doc-497	A
	Machined	1	Ferrule Holder 10mm Theta-Phi	DESI-doc-499	A
	Machined	1	Phi Friction Tab 10mm Theta-Phi	DESI-doc-500	A
	Machined	1	Theta Friction Tab 10mm Theta-Phi	DESI-doc-501	A
	Machined	1	Idler Spacer 10mm Theta-Phi	DESI-doc-505	A
	Machined	1	Theta Shaft 10mm Theta-Phi	DESI-doc-506	A
	Machined	1	Theta Shaft Extender 10mm Theta-Phi	DESI-doc-521	A
	Machined	1	Ferrule Holder Spacer 10mm Theta-Phi	DESI-doc-571	A
	Motor	2	4mm BLDC gearmotor	Namiki SBL04-0829PG337 or Maxon K13012 EC4+GP4C	-

Tooling Parts List

TOOLING					
	Assembly		Fiber Positioner Bonding 10mm Theta-Phi	DESI-doc-525	
	Hardware	1	Mitutoyo Grade 0 Rectangular Gauge Block, .0340" Size	19575A15	-
	Hardware	2	Mitutoyo Grade 0 Rectangular Gauge Block, .1020" Size	19575A31	-
	Hardware	1	Mitutoyo Grade 0 Rectangular Gauge Block, .1007" Size	19575A31	-
	Hardware	1	Mitutoyo Grade 0 Rectangular Gauge Block, .1080" Size	19575A31	-
	Hardware	1	Gauge Pin Class X, 0.049" plus	21135A33	-
	Hardware	6	2mm x 10mm precision pin, fit in H6 hole (+0.006, -0), make/select from Z_0.1180"+, Z_0.1180"-, X_0.0788"+	23055A002, 21135A34	-
	Hardware	6	3mm x 20mm precision pin, fit in H6 hole (+0.006, -0), make/select from Z_0.0785"+, X_0.0787"+, X_0.1181"+	23055A002, 21135A34, 23065A504	-
	Hardware	2	3/64 x 1/2 Acetal Dowel Pin	97155A115	-
	Hardware	1	SHCS M2 x 8	92290A015	-
	Hardware	2	SHCS M3 x 12	92290A117	-
	Hardware	2	SHCS M3 x 25	92290A124	-
	Hardware	10	SHCS M3 x 3	92290A109	-
	Machined	1	Bonding Chuck 10mm Theta-Phi	DESI-doc-507	A
	Machined	1	Aft Fixture Plug 10mm Theta-Phi	DESI-doc-508	A
	Machined	1	Aft Fixture Shaft 10mm Theta-Phi	DESI-doc-509	A
	Machined	1	Phi Drive Spring Block 10mm Theta-Phi	DESI-doc-510	A
	Machined	1	Upper Housing Fixture Block 10mm Theta-Phi	DESI-doc-511	A
	Machined	2	Spring Plunger Modification 10mm Theta-Phi	DESI-doc-512	B
	Machined	1	Ferrule Fixture Tube 10mm Theta-Phi	DESI-doc-513	A
	Machined	5	Test Thread Plug 10mm Theta-Phi	DESI-doc-590	A
	Tool	1	T5 Torx Driver	53415A21	
	Tool	1	T1 Torx Driver	52995A22	
	Tool	1	0.28" Hex Driver	7270A37	

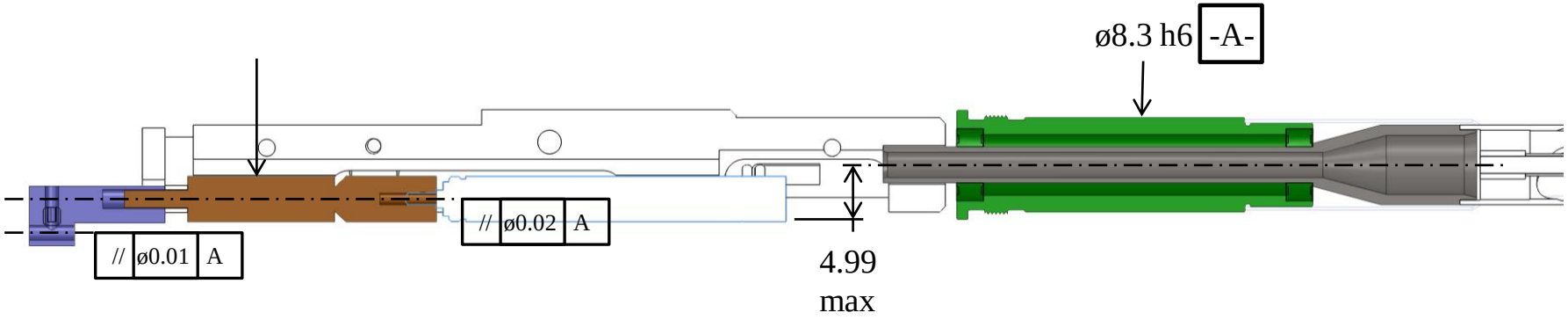
section view

- fiber routing shown in red
- phi motor wiring follows fiber routing



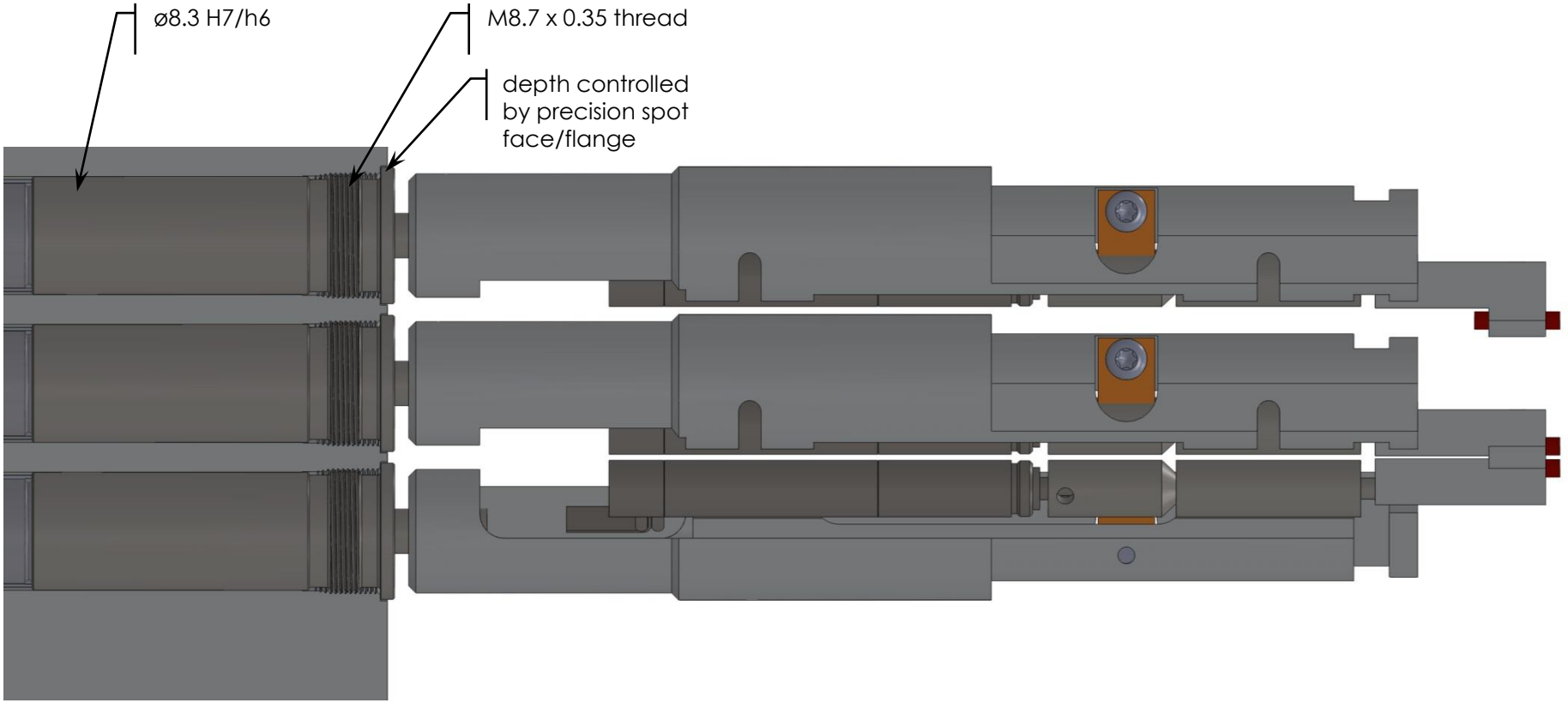
Critical Alignments

- **Shaft runout of bearing cartridges < 5um.**



Interface to focal plate

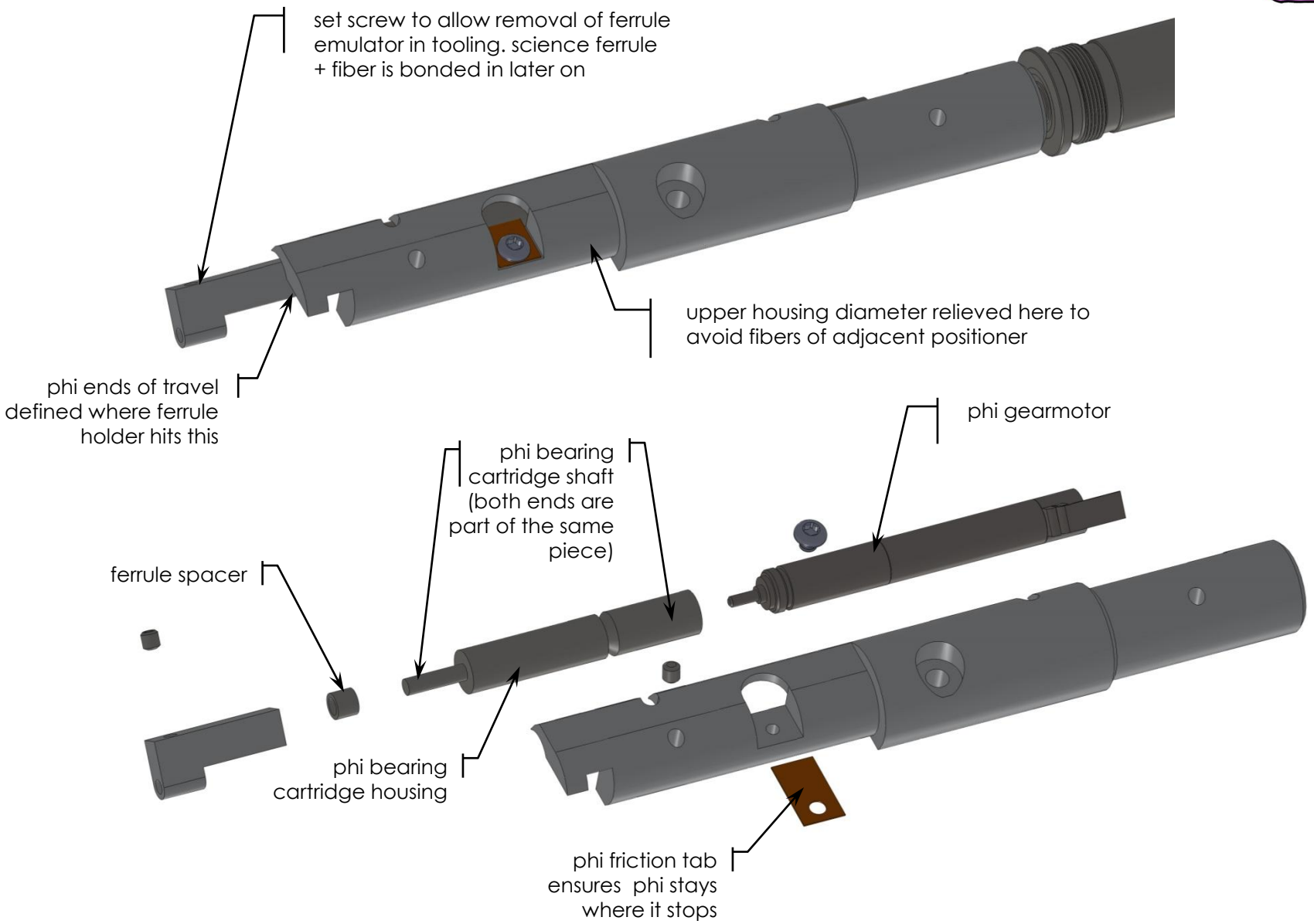
- features machined into theta bearing cartridge housing
- torque is applied at opposite end where there is easier access



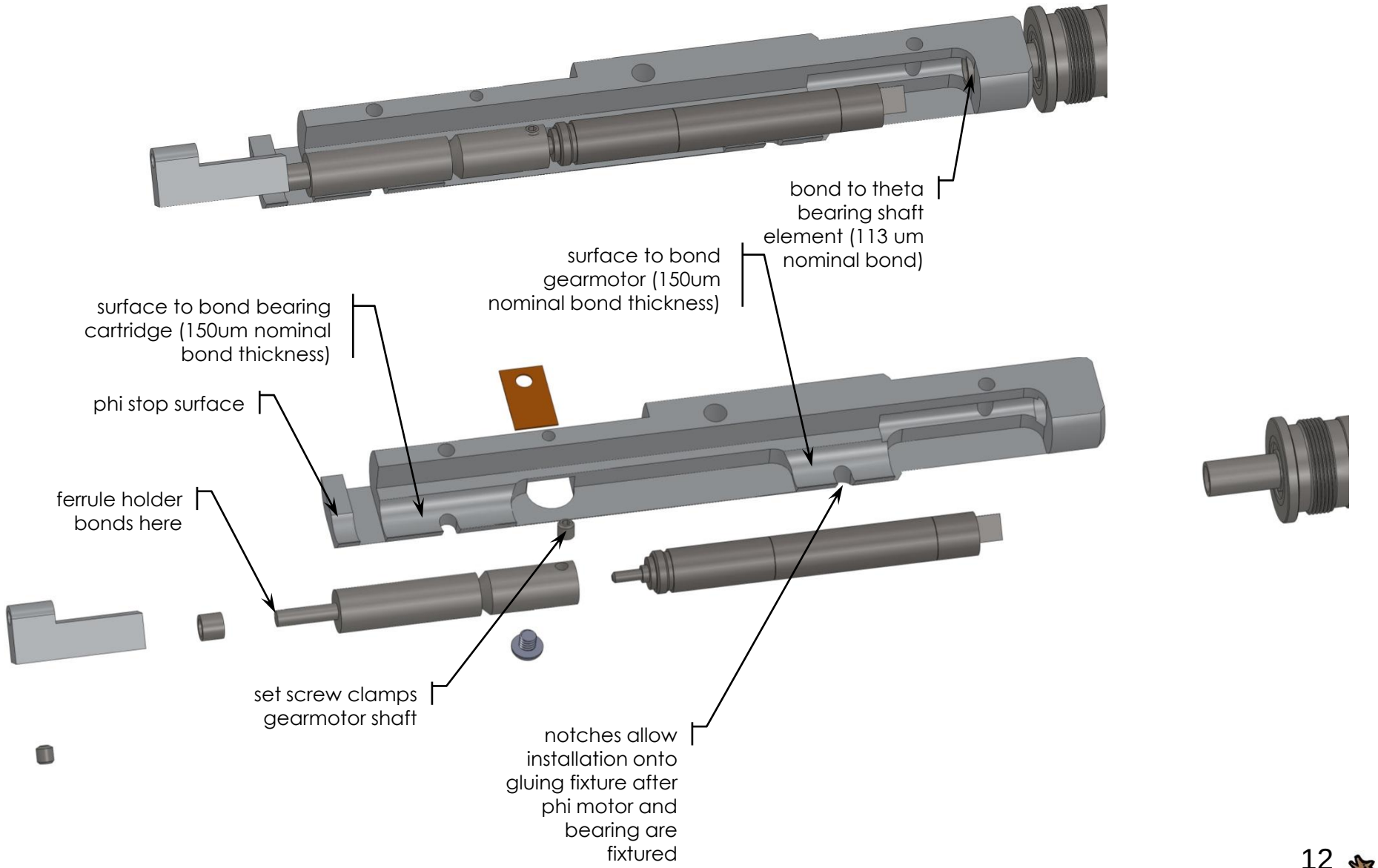
M8.7 x 0.35 Thread Specification

- Custom thread specification for positioner to focal plate interface.
- Specifications based on M thread standards as given in Machinery's Handbook, 24th edition.
- Internal thread, M8.7 x 0.35 - 6G:
  - Major diameter: 8.719/8.865
  - Pitch diameter: 8.492/8.587
  - Minor diameter: 8.340/8.440
- External thread, M8.7 x 0.35 – 6f
  - Major diameter: 8.581/8.666
  - Pitch diameter: 8.368/8.439
  - Minor diameter: 8.152/8.287

Phi assembly

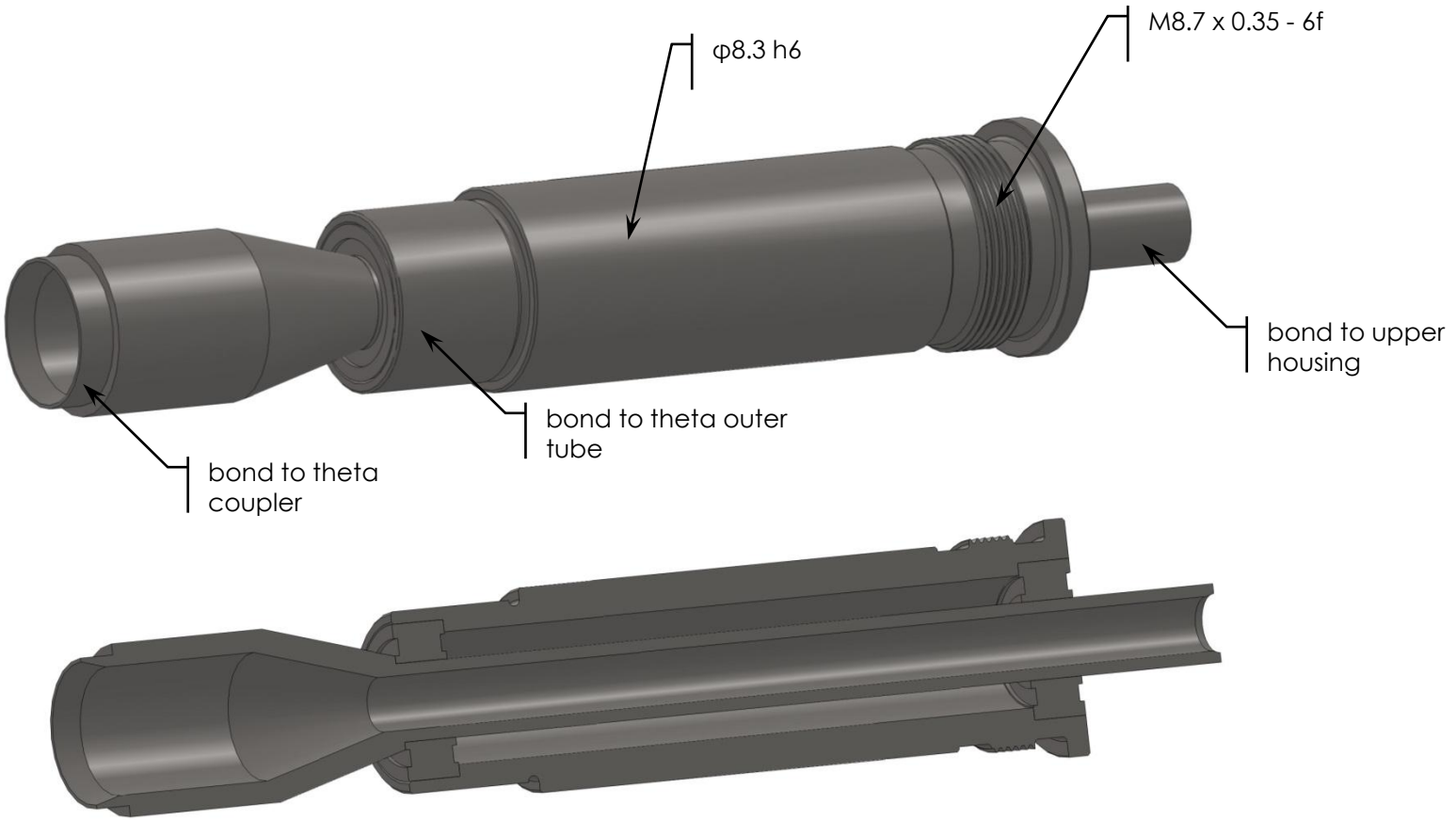


Phi assembly

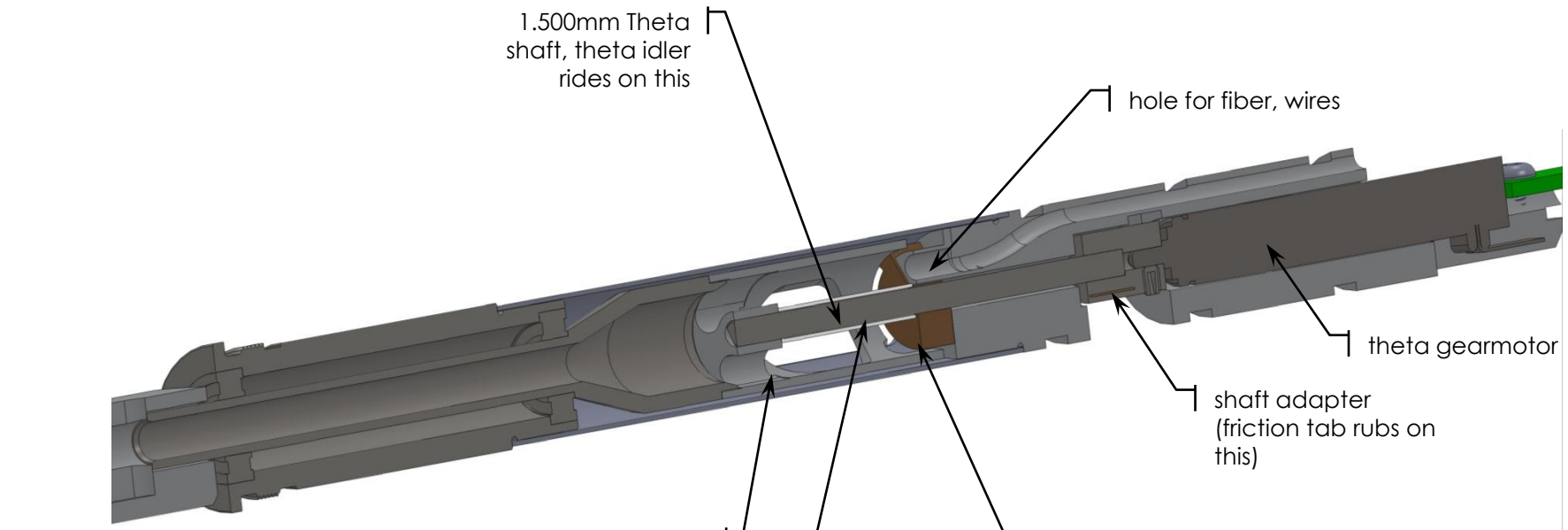


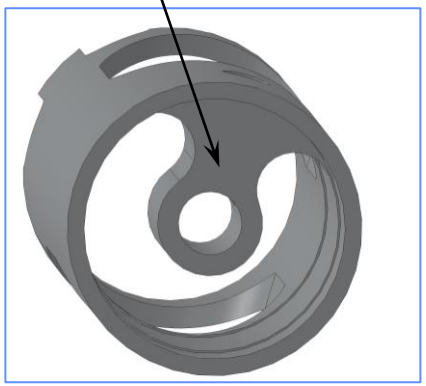
theta bearing cartridge

- concentricity and runout are on the order of 5um
- hollow shaft allows fiber, ferrule, and phi motor wires to feed through.

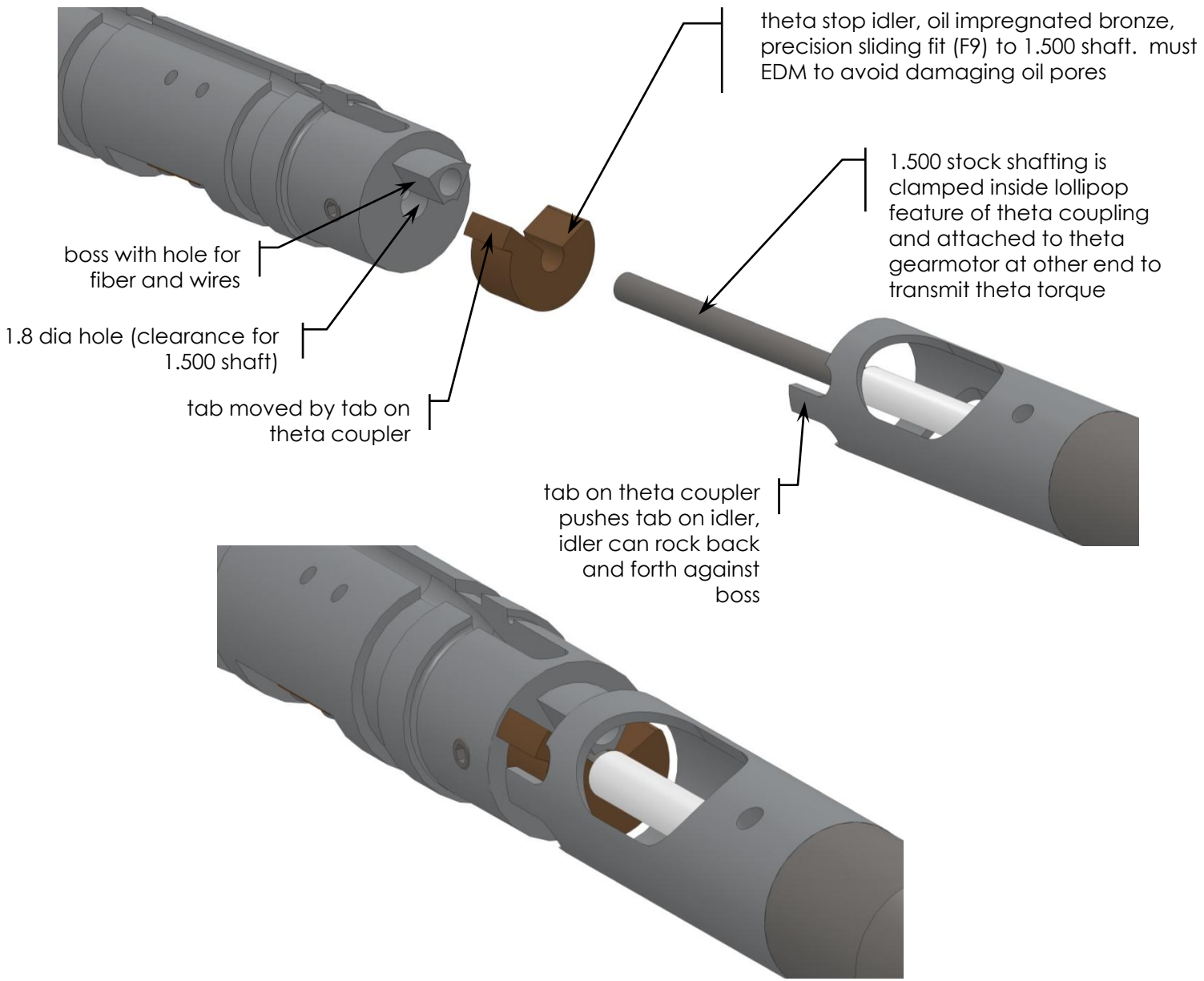


Theta drive section view

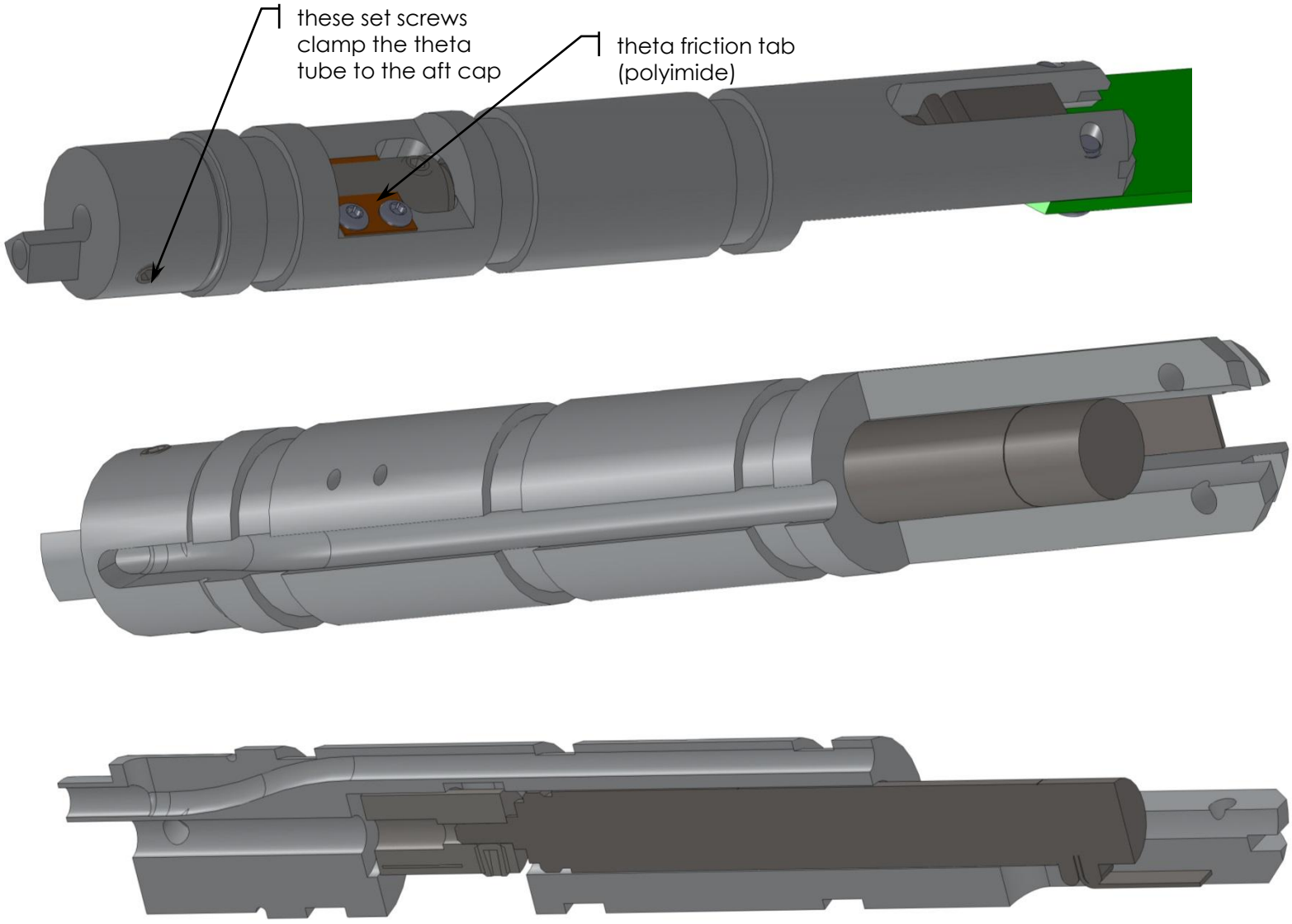




Theta stop allows more than 360° travel with repeatable hard stops at ends

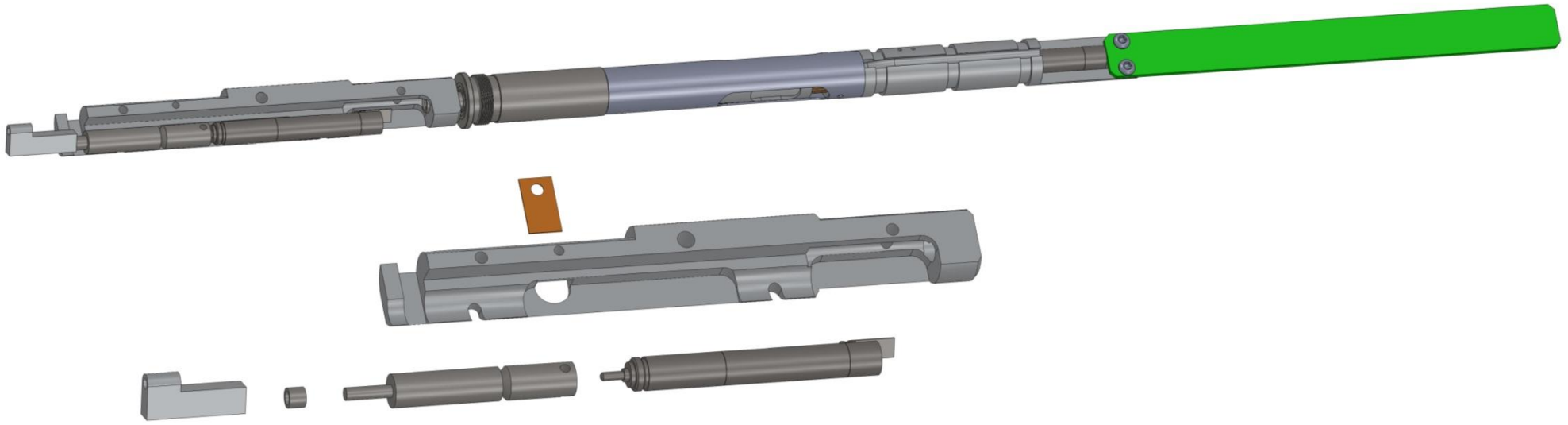


aft cap


these set screws
clamp the theta
tube to the aft cap
theta friction tab
(polyimide)

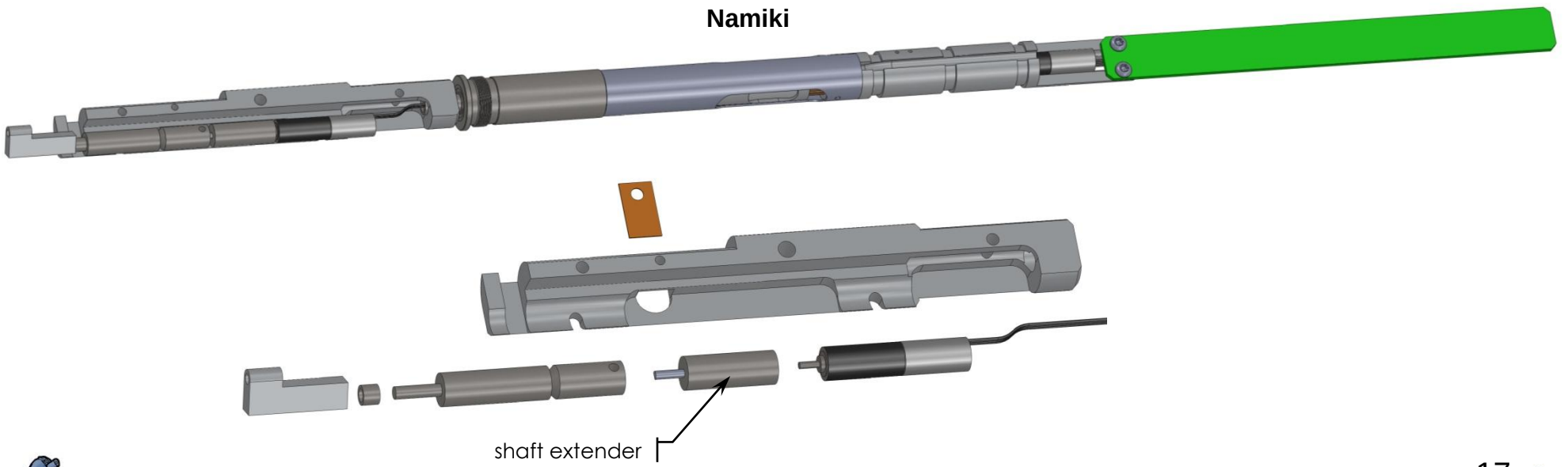
Same parts for Namiki or Maxon gearmotor

- **Add shaft extenders to shorter Namikis (both axes).**



Maxon

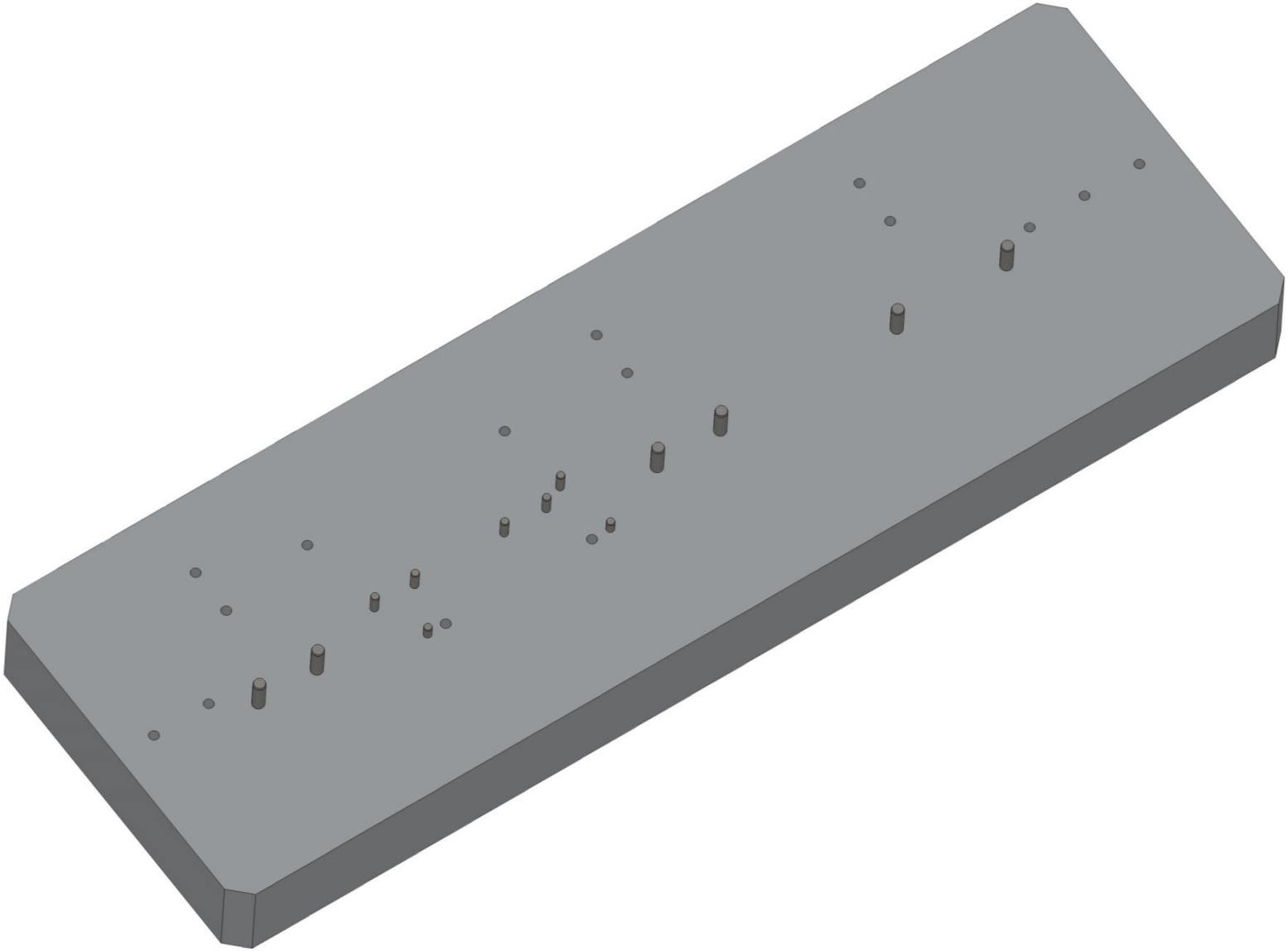
Namiki



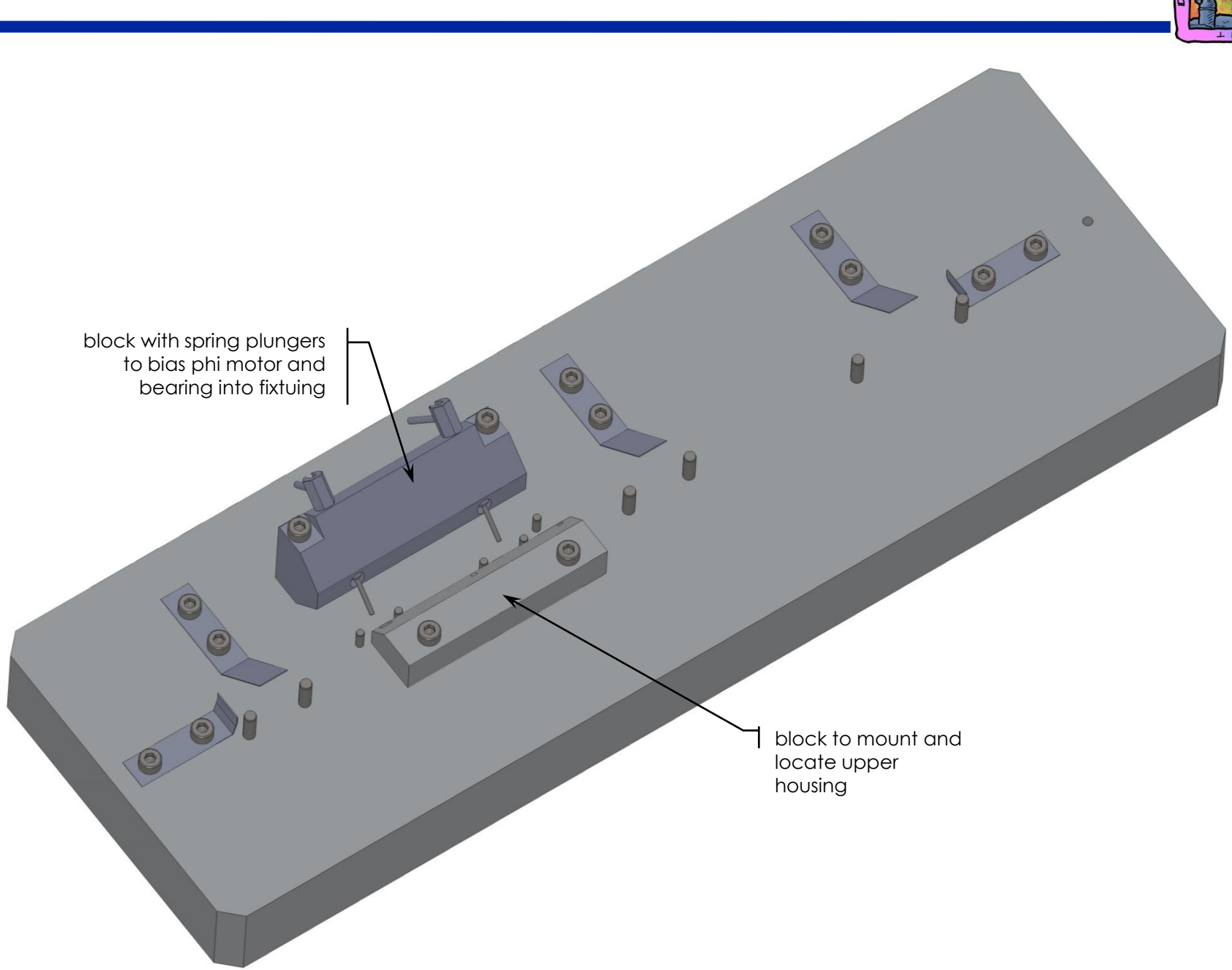
Fixturing

- Goal is to make the theta bearing axis, the phi bearing axis, and the ferrule axis as parallel as practical (to hundredths of a degree).
- Use one lapped aluminum base piece, flat to ~5um, with precision pins installed with location tolerance of 20um diameter.
- Use gauge blocks to set various heights above the base piece.
- Use leaf springs to bias parts into ‘V’ formed by gauge blocks and pins.

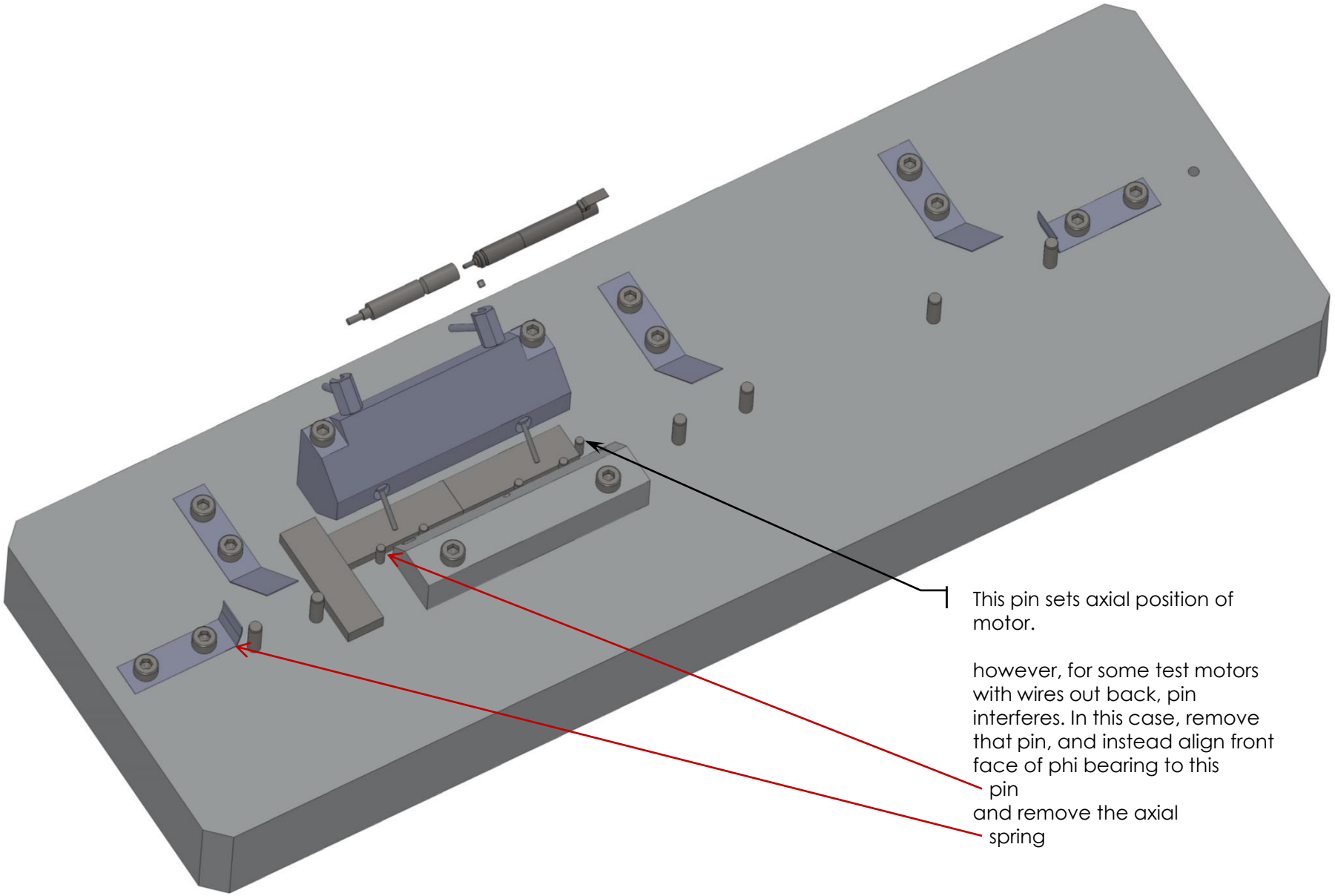
Fixture base with pins



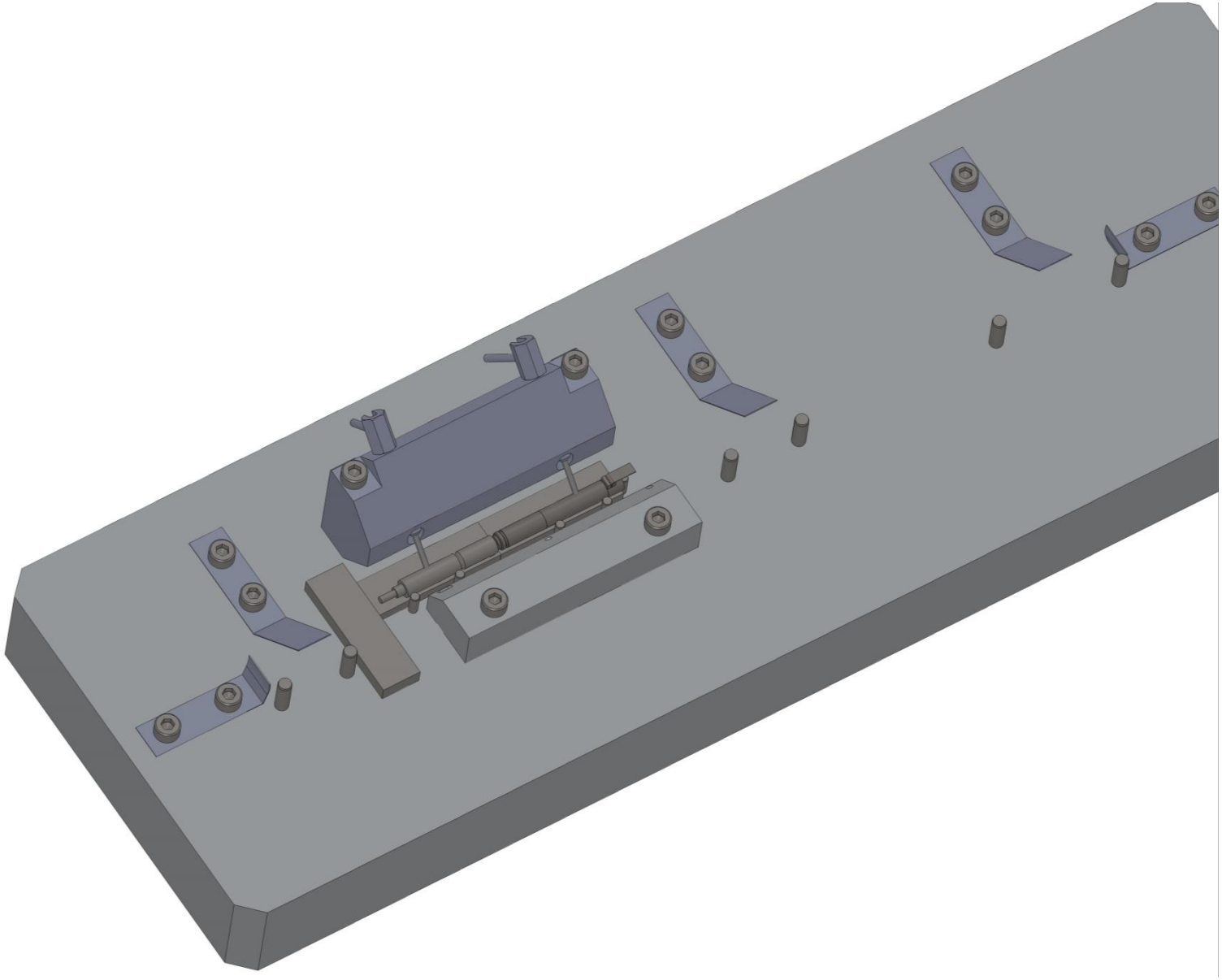
Add biasing springs and other fixture items



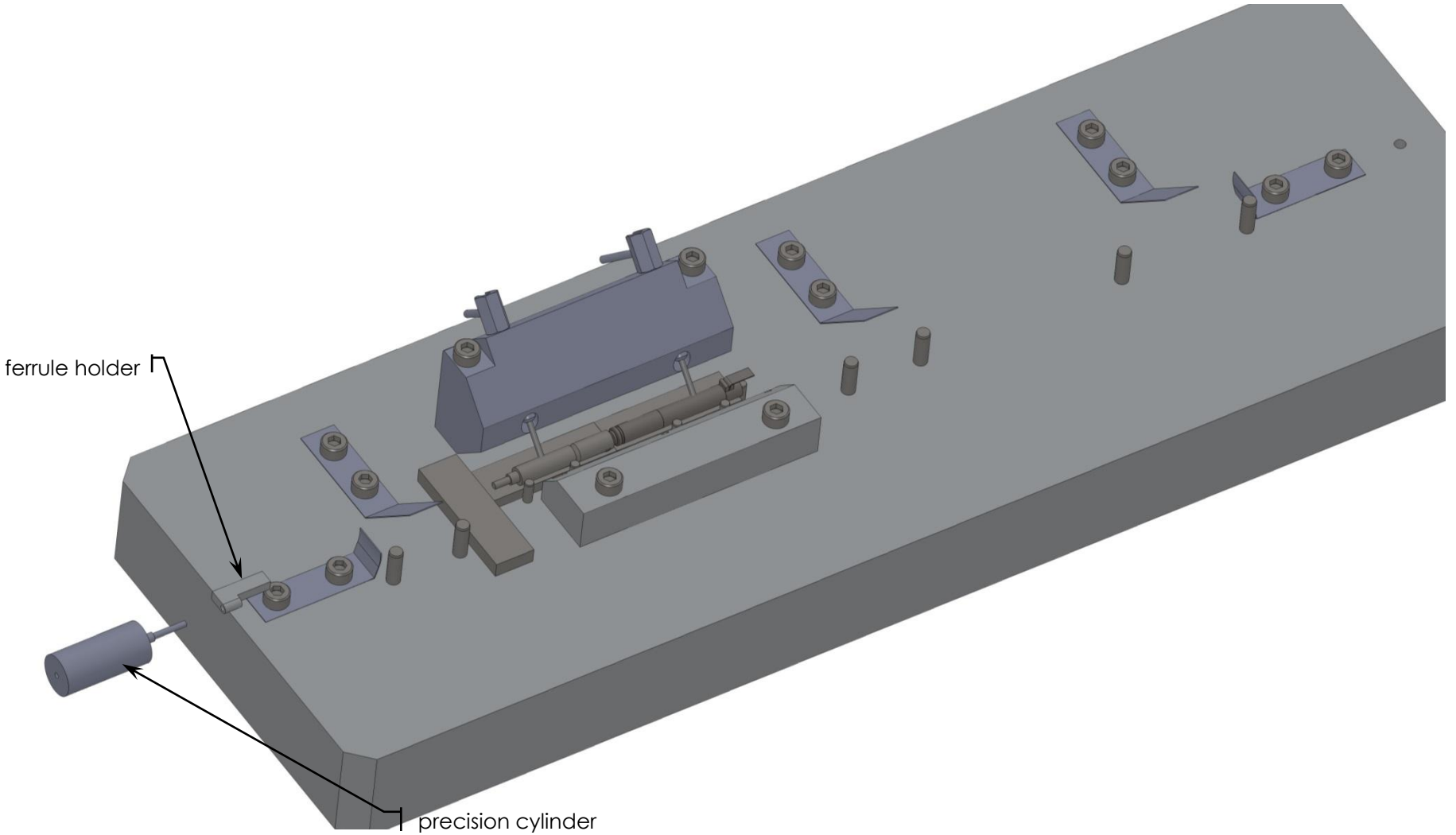
gauge blocks for motor and bearing, ready to fixture motor and bearing



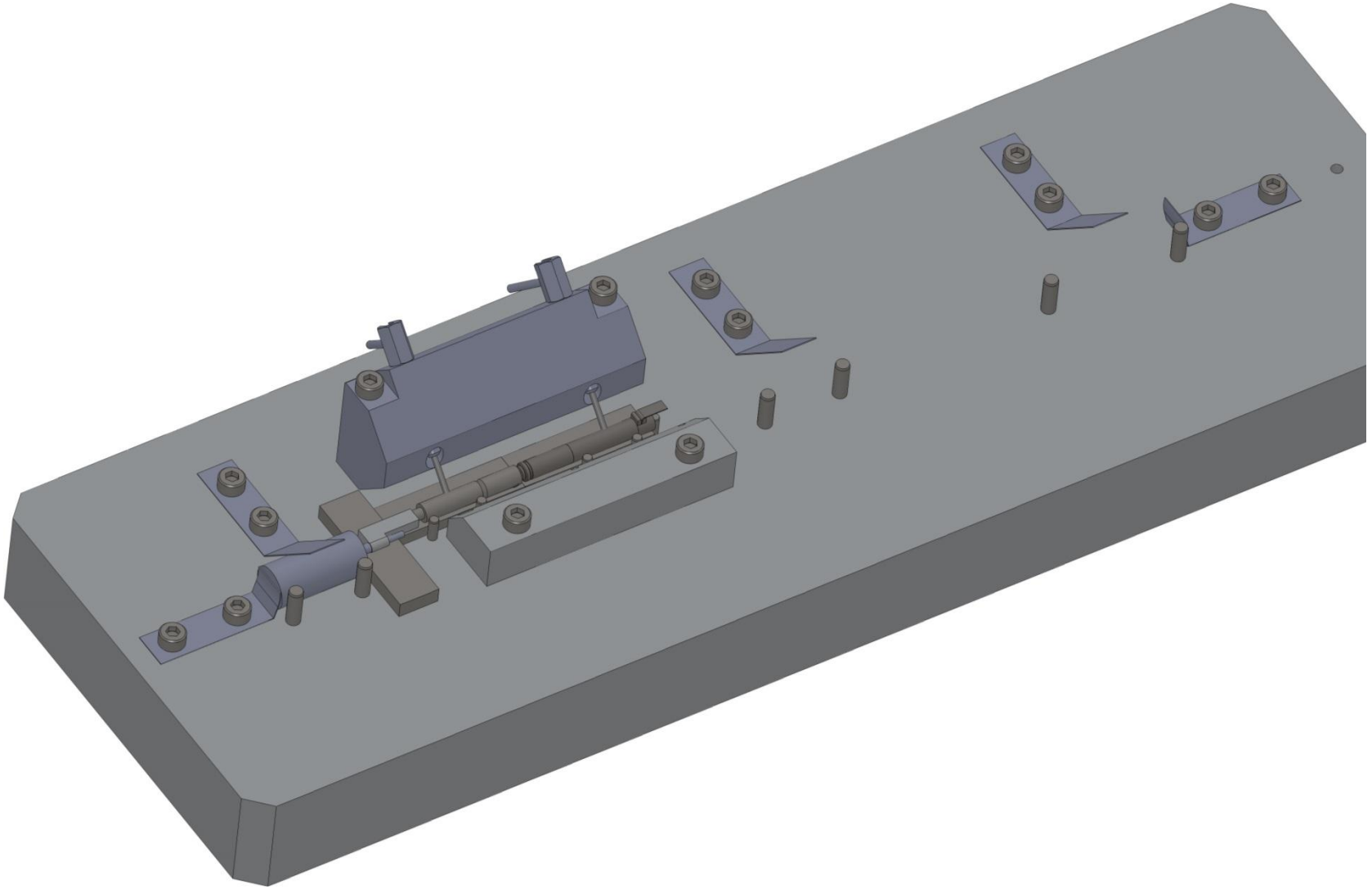
spring plungers pressing motor and bearing into location



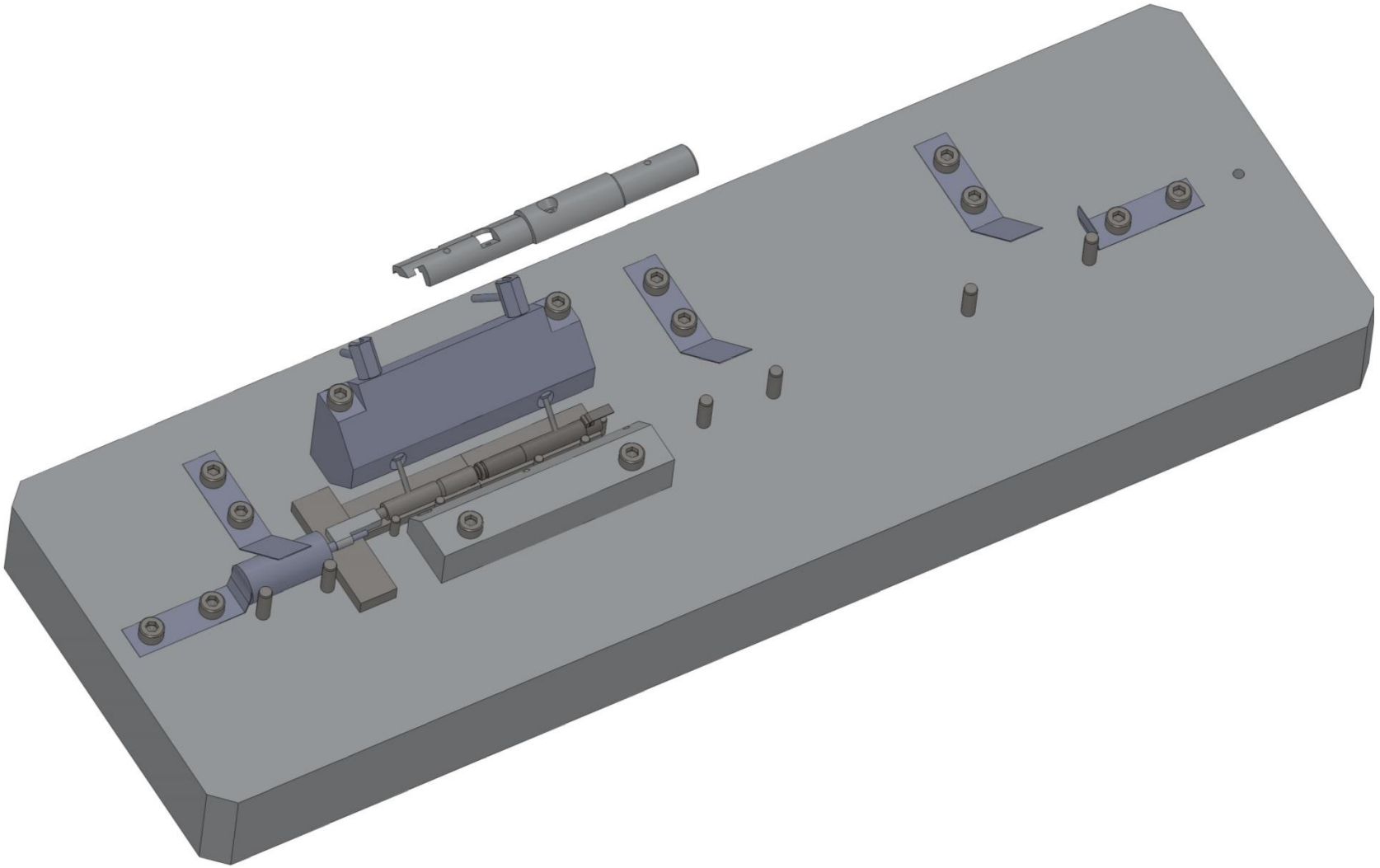
apply glue, ready to fixture ferrule holder



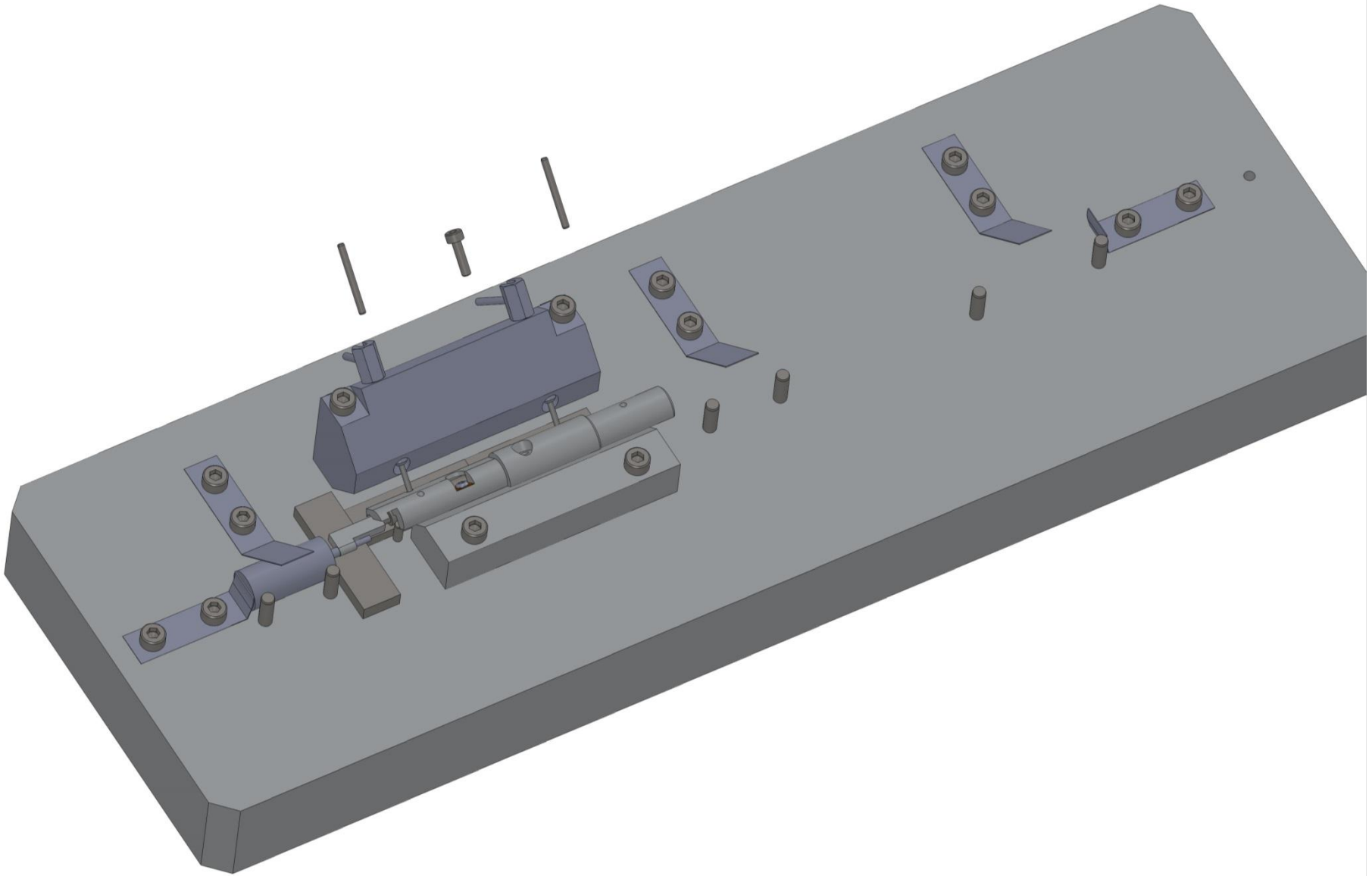
ferrule holder now fixtured to bearing with glue curing



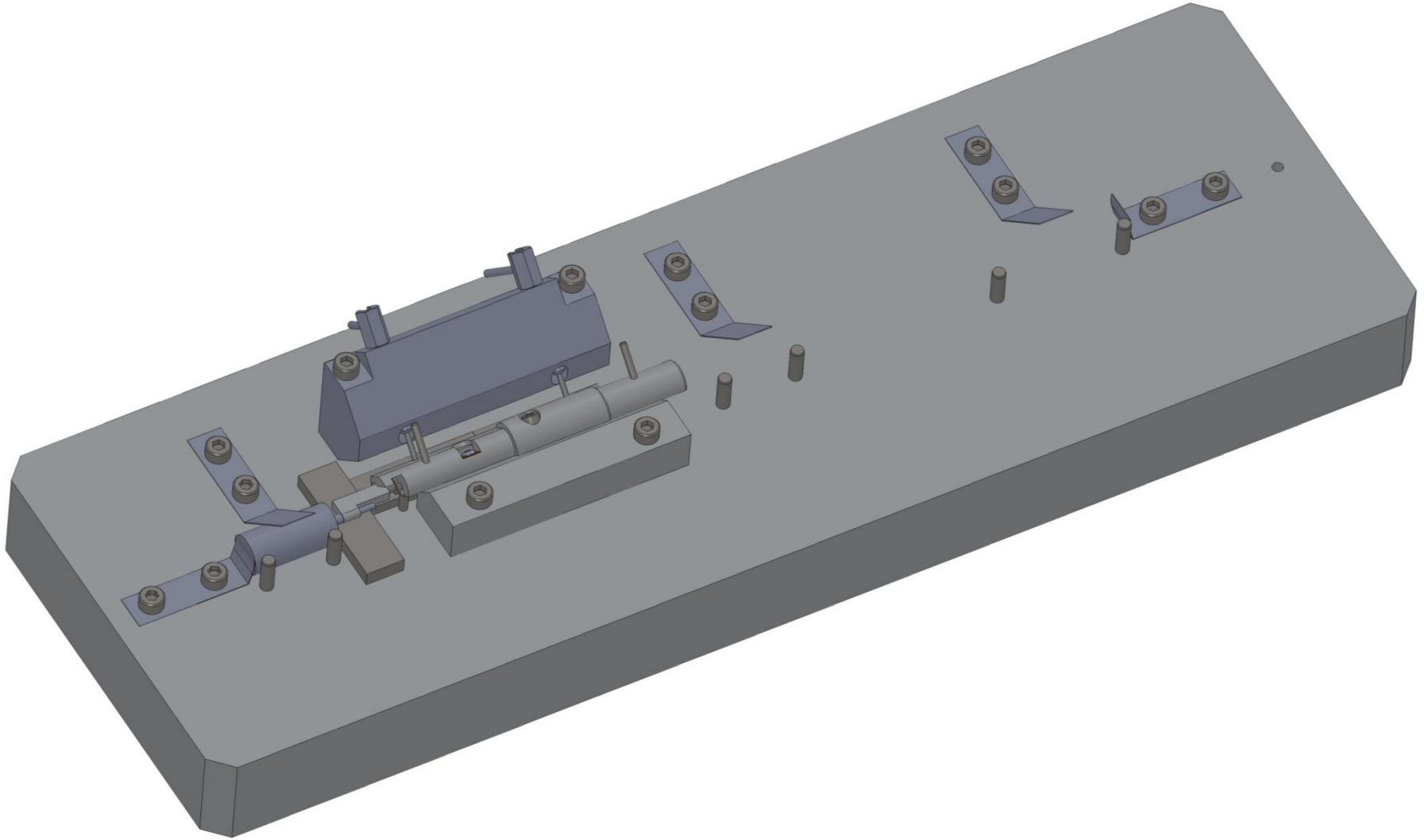
put glue on upper housing where in the channel for bearing and motor



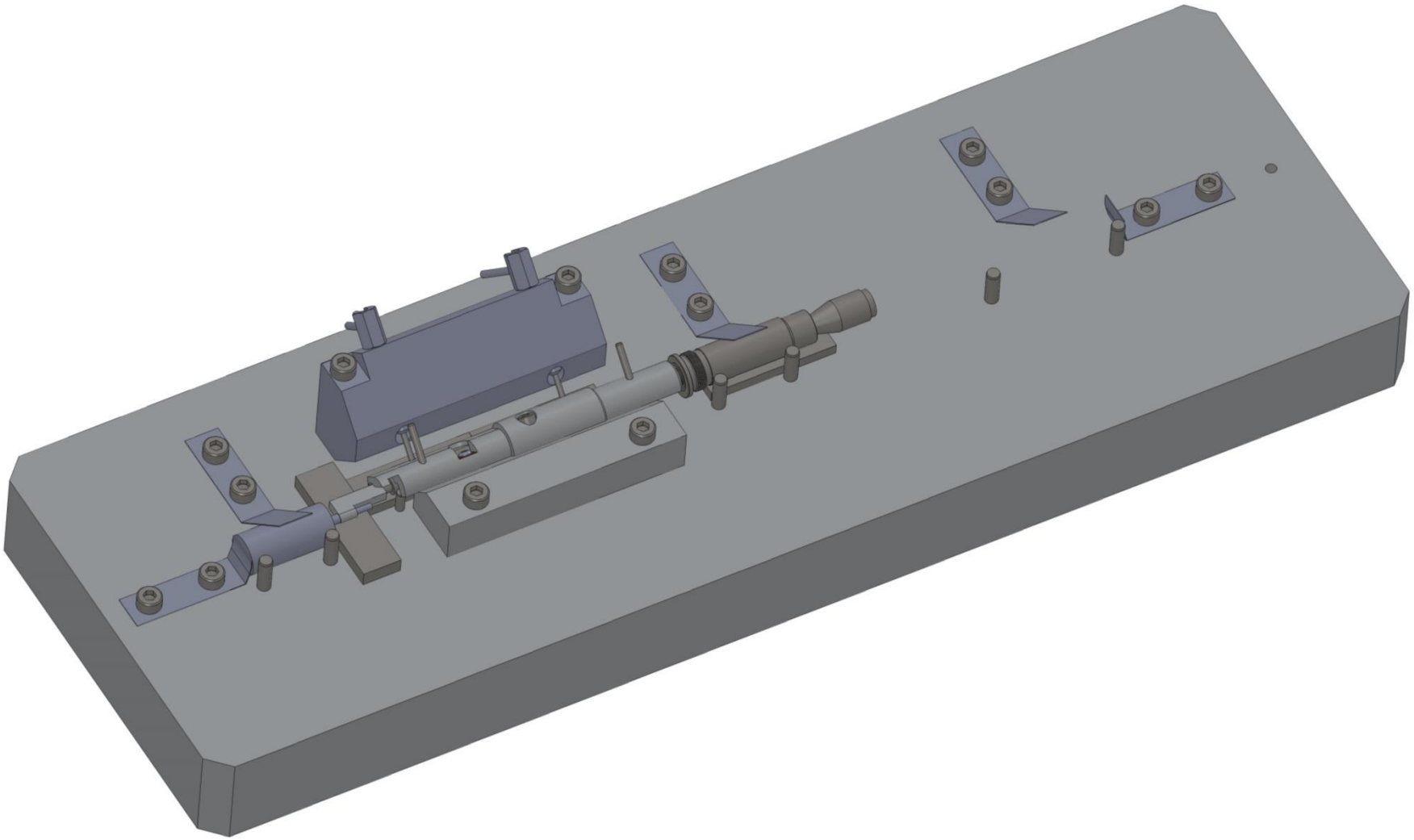
upper housing in place, alignment pins and hold-down screw ready to install



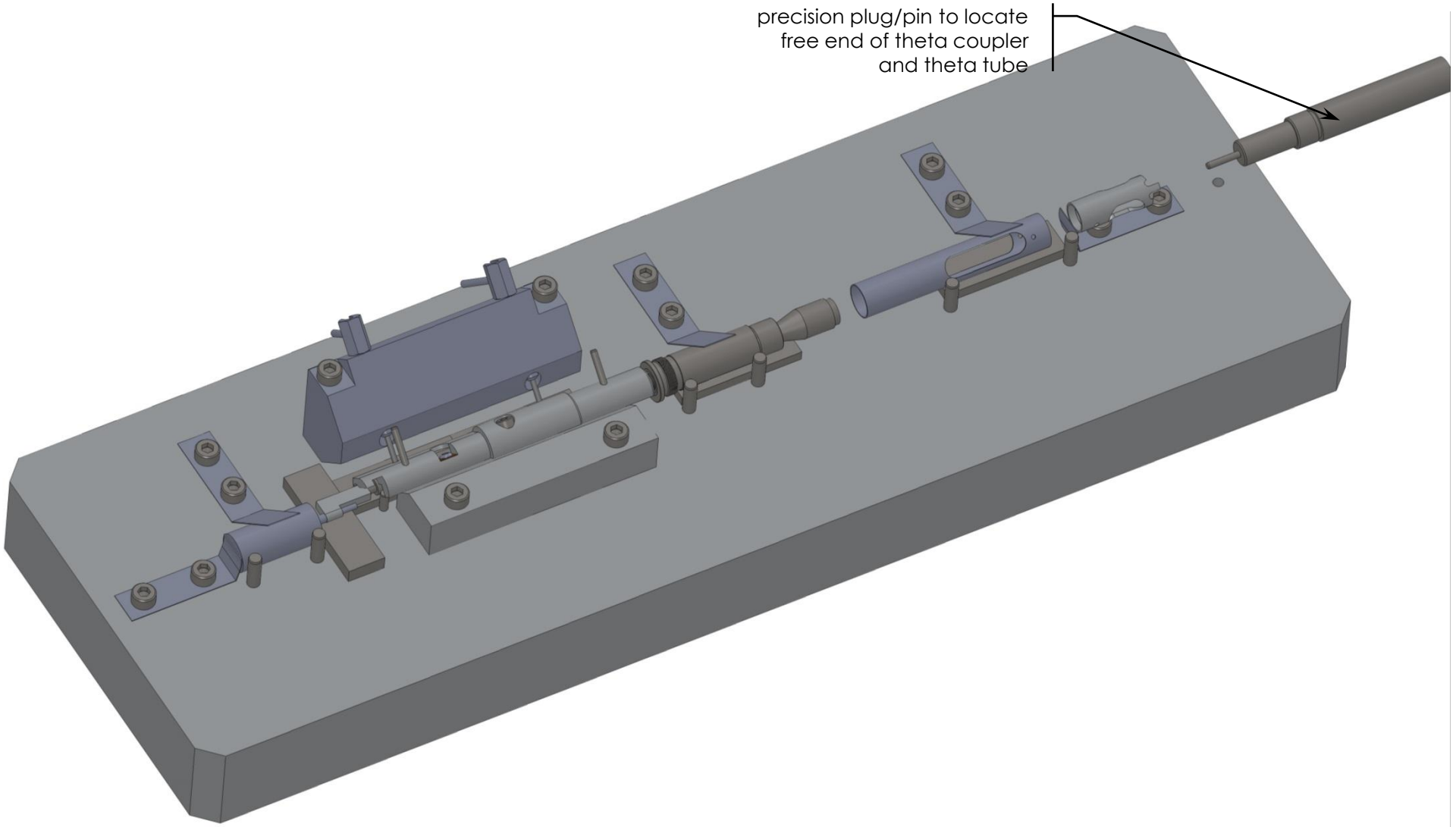
upper housing locked in place, curing



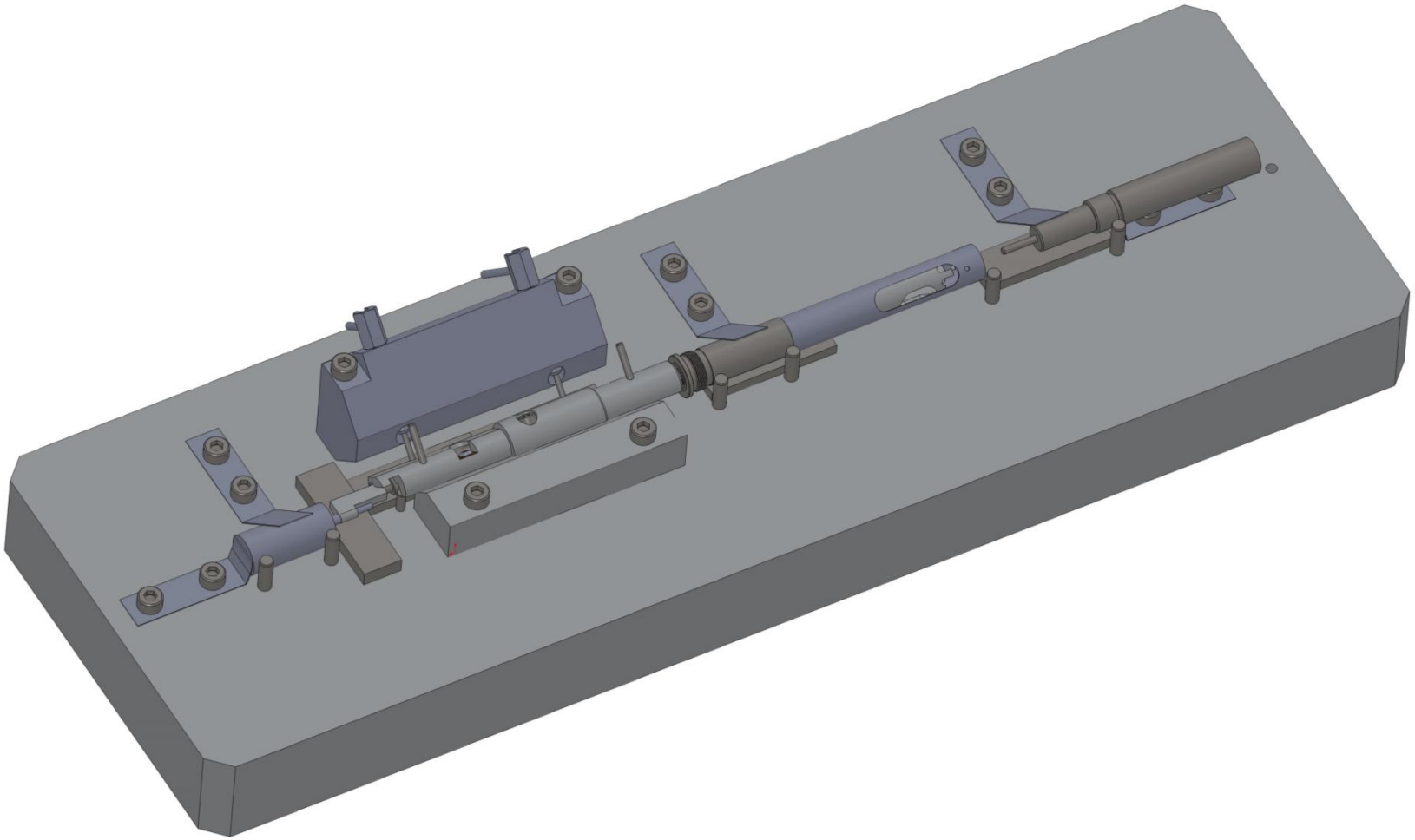
put glue on theta bearing shaft, install on fixture



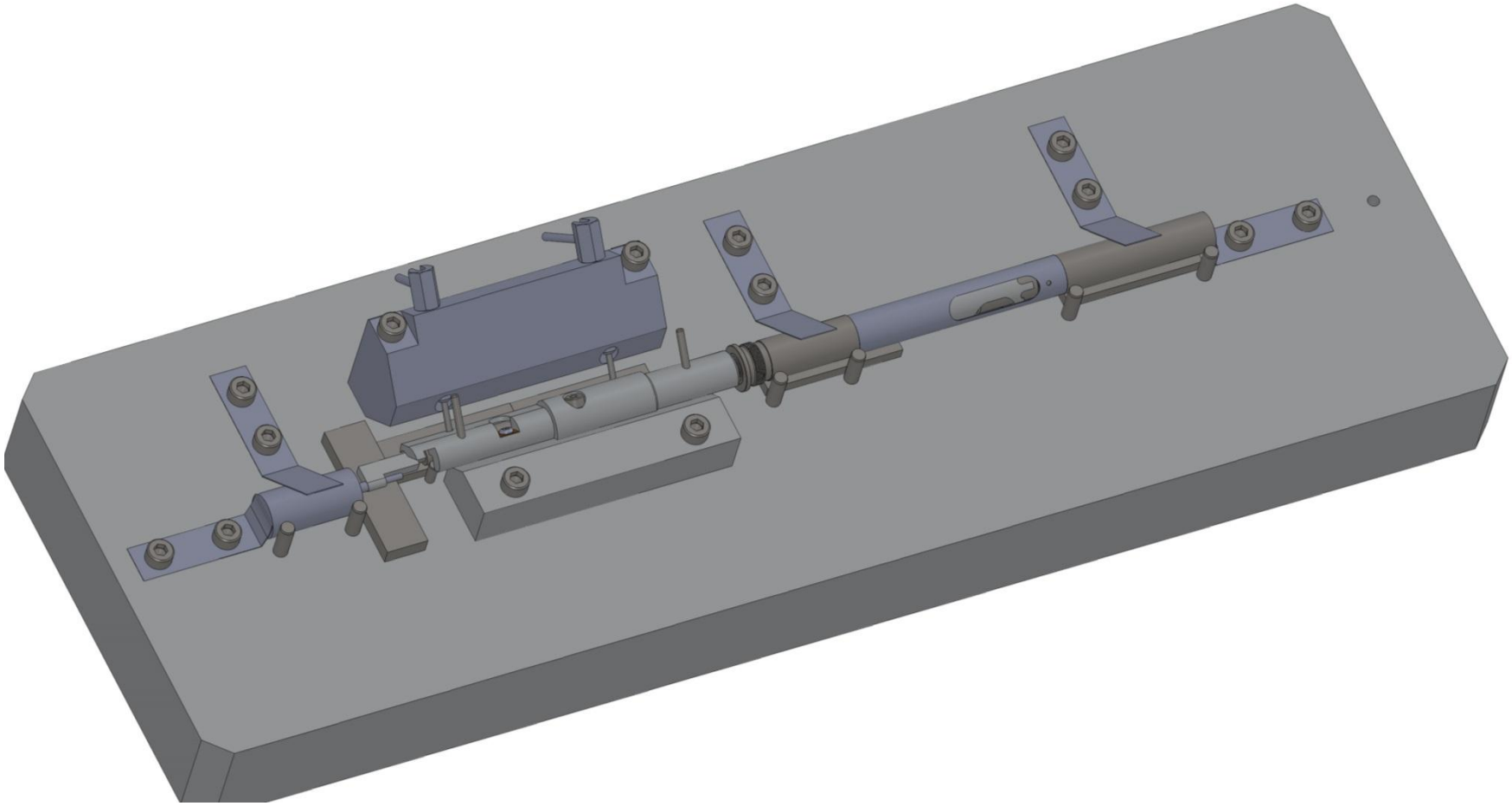
put glue where needed for theta coupler and theta tube, ready to fixture



Theta tube, theta coupler in place, ready for plug to locate them

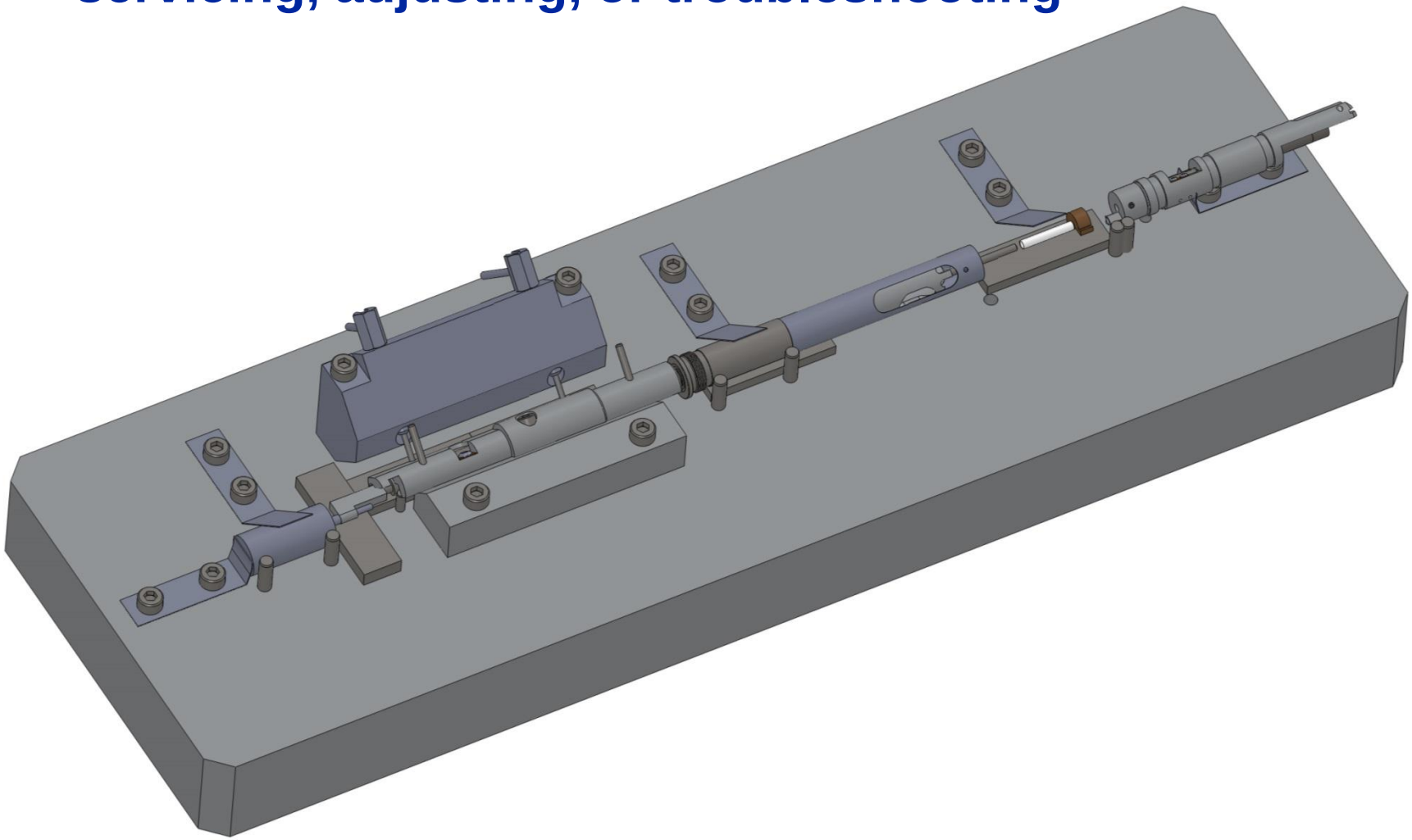


theta coupler and theta tube in place, curing



after curing, install theta stop hardware, glue in aft cap

- for prototypes, aft cap can be clamped in place to allow servicing, adjusting, or troubleshooting



positioner fixtured with epoxy curing